

Generalized Estimation Equations for Thermophysics Properties of Saturated Fluids and the Saturated Properties Table of HFC-227ea

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In this paper, generalized estimation equations for the thermophysical properties of saturated fluids developed by our group in recent years were introduced, namely enthalpy, entropy and density of saturated liquids and gases, enthalpy of vaporization and saturated vapor pressure. The calculated results agree well with the recommended data in literatures. According to these equations and the measurement results, the saturated properties table of HFC-227ea was given.

1. The Generalized Estimation Equation of Saturated Liquid Enthalpy

$$\Delta h'_r = \Delta T_r (0.70 + 0.07 \log \Delta T_r)$$

$$\text{where, } \Delta h'_r = \frac{h_c - h'}{h_c - h'_b} \quad \square \quad \Delta T_r = \frac{T_c - T}{T_c - T_b}$$

2. The Generalized Estimation Equation of Enthalpy of Vaporization:

$$\Delta h_{v,r} = \Delta T_r (0.360 + 0.044 |1 - \sqrt{\Delta T_r}|)$$

$$\text{where, } \Delta h_{v,r} = \frac{\Delta h_v}{\Delta h_{v,b}}$$

3. The Generalized Estimation Equation of Saturated Gas Enthalpy:

$$\Delta h''_r = \Delta h'_r - \Delta h_{v,r} \cdot \Psi$$

$$\text{where, } \Psi = \frac{\Delta h_{v,b}}{h_c - h'_b}$$

4. The Generalized Estimation Equation of Saturated Liquid Density:

$$\Delta \rho_r = \Delta T_r (0.444 + 0.017 \ln \Delta T_r)$$

$$\Delta \rho_r = \frac{\rho'_r - \rho_c}{\rho'_b - \rho_c}$$

5. The Generalized Estimation Equation of Saturated Gas Density:

$$\frac{\ln Z}{\ln Z_c} = \left[\rho_r^m + 0.0198 - 0.11 |T_r - 0.82| + 0.07 (1 - T_r)^2 \right]$$

$$\text{where, } m = 0.256 + 1.85 Z_c + 0.066 (1 - P_r^{40})$$

6. The Generalized Estimation Equation of Saturated Vapor Pressure:

$$\frac{\ln P_r}{\ln P_{br}} = \frac{(1/T_r - 1)}{(1/T_{br} - 1)} [1 + \eta(T_r, T_{br})]$$

$$\text{where, } \eta(T_r, T_{br}) = 1.17 T_{br} B (T_r - T_{br}) (T_r - B) \quad \square \quad B = K (1.725 - 2.02 Z_c / T_{br}) \quad \square \quad Z_c = P_c V_c / RT_c,$$

$$P_r = P / P_c, \quad T_r = T / T_c, \quad K \approx 1$$

7. The Generalized Estimation Equation of Saturated Liquid Entropy:

$$\Delta s' = s' - s'_0 = \frac{h' - h'_0}{T - T_0} \cdot \ln \frac{T}{T_0} - \frac{v' - v'_0}{T - T_0} \cdot (p - p_0)$$

8. The Generalized Estimation Equation of Saturated Gas Entropy:

$$\Delta s'' = s'' - s'_0 = \frac{h' - h'_0}{T - T_0} \cdot \ln \frac{T}{T_0} - \frac{v' - v'_0}{T - T_0} \cdot (p - p_0) + \frac{\Delta h_v}{T}$$

Saturated properties of HFC-227ea

T	P	v'	v''	h'	h''	s'	s''
K	KPa	$\text{m}^3 \cdot \text{kg}^{-1} \times 10^3$		$\text{KJ} \cdot \text{kg}^{-1}$		$\text{KJ} \cdot \text{kg}^{-1} \cdot \text{K}^{-1}$	
240.15	46.708	0.62490	243.76670	159.117	296.891	0.84070	1.41440
245.15	59.784	0.63123	193.51510	165.161	301.049	0.86564	1.41994
250.15	75.622	0.63787	155.16355	171.255	305.217	0.89025	1.42578
255.15	94.613	0.64481	125.55419	177.399	309.398	0.91456	1.43190
256.728 ^a	101.325	0.64707	117.64916	179.350	310.720	0.92218	1.43389
260.15	117.172	0.65208	102.46491	183.599	313.586	0.93861	1.43827
265.15	143.738	0.65970	84.29352	189.857	317.765	0.96240	1.44480
270.15	174.774	0.66769	69.86673	196.177	321.935	0.98596	1.45147
273.15	195.741	0.67267	62.63669	200.000	324.431	1.00000	1.45555
275.15	210.764	0.67608	58.31570	202.563	326.093	1.00932	1.45828
280.15	252.213	0.68490	48.99130	209.021	330.238	1.03251	1.46520
285.15	299.648	0.69420	41.40464	215.556	334.370	1.05555	1.47222
290.15	353.613	0.70401	35.18467	222.174	338.486	1.07846	1.47933
295.15	414.674	0.71440	30.04766	228.883	342.584	1.10128	1.48651
300.15	483.415	0.72542	25.77504	235.691	346.663	1.12404	1.49376
305.15	560.443	0.73716	22.19718	242.608	350.718	1.14677	1.50106
310.15	646.383	0.74971	19.18141	249.645	354.747	1.16951	1.50839
315.15	741.888	0.76320	16.62327	256.816	358.746	1.19231	1.51574
320.15	847.634	0.77778	14.43984	264.139	362.709	1.21521	1.52309
325.15	964.329	0.79364	12.56479	271.633	366.628	1.23827	1.53043
330.15	1092.719	0.81105	10.94465	279.324	370.497	1.26158	1.53773
335.15	1233.592	0.83034	9.53591	287.245	374.302	1.28521	1.54496
340.15	1387.789	0.85202	8.30273	295.441	378.028	1.30929	1.55209
345.15	1556.223	0.87677	7.21513	303.970	381.651	1.33398	1.55905
350.15	1739.897	0.90570	6.24736	312.918	385.137	1.35951	1.56576
355.15	1939.938	0.94059	5.37622	322.417	388.427	1.38621	1.57208
360.15	2157.655	0.98474	4.57871	332.687	391.421	1.41466	1.57774
365.15	2394.641	1.04537	3.82692	344.156	393.903	1.44595	1.58218
370.15	2653.037	1.14433	3.06872	357.940	395.252	1.48286	1.58366
371.15	2707.554	1.17483	2.90481	361.245	395.221	1.49157	1.58311
372.15	2763.105	1.21311	2.72979	364.900	394.980	1.50113	1.58196
373.15	2819.751	1.26499	2.53460	369.110	394.384	1.51201	1.57974
374.15	2877.585	1.34820	2.29340	374.443	393.007	1.52549	1.57510
375.04 ^b	2930.000	1.69492	1.69492	388.560	388.560	1.55924	1.55924

^a normal boiling temperature ^b critical point